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ECOLOGICAL-FAUNISTIC ANALYSIS OF RODENT HELMINTHES (MAMMALIA: RODENTIA) OF THE NORTHEAST PARTS OF UZBEKISTAN

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ABSTRACT

A total of 1057 specimen of rodents of 12 species, inhabiting the territory of the Northeast of Uzbekistan were studied. 46 species of helminthes have been identified, belonging to four classes; Cestoda, Trematode, canthocephala and Nematode.

The class Cestoda is represented by 17 species, Trematoda-5 species, Acanthocephala-1 species, and Nematod-23 species. The total infection rate of the studied rodents was 39.3%. The parameters of infestation of individual species and groups of rodents with parasitic worms vary widely. The lowest percentage of helminthes infestation in natural muskrat populations was about 3.3%. A high infection rate was noted in gray rats-50.4%, ground squirrels (46.1%) and house mice (42.3%) occupy the next positions in these indicators.

The helminth fauna of individual groups of rodents differs significantly. We can see that in squirrels-27, in mice-21, in gerbils-18, and in nutri-2 species were recorded. Comparison of these data, it is possible to characterize the helminth fauna of rodents of various families, which largely depends on the habitat and lifestyle of the studied animals.

Keywords: Helminth fauna, Cestodes, Acanthocephalans, Trematodes, Nematodes, Northeastern region, Uzbekistan.

INTRODUCTION

In scientific centers of the world, a much attention is paid to the study of rodent helminthes, which are a convenient model object in the field of fauna and population ecology. On their example, many aspects of the formation of faunistic complexes of helminthes, inherent in certain taxonomic groups of hosts are considered.

In addition, rodents are of great practical importance. Among them, there are a number of valuable trade animals (muskrat, nutria, marmots, and squirrels). The fur of these animals, especially the muskrat and nutria are valued highly. The negative role of rodents is very significant. Most of them cause significant damage to agriculture, eating grain, destroying valuable vegetation on plantations and vegetable gardens, and damaging fruit crops. Many rodents are the hosts of helminthes-causative agents of dangerous human diseases and economically useful animals. To study the ecological and faunistic features of rodent parasites in specific regions helps to determine the role of the helminth fauna of micrommali in the epidemiology and epizootology of helminthiases.

Scientific research on the fauna and ecology of rodent helminthes was carried out in a number of CIS countries (Matsaberidze, G.V., 1966; Merkusheva, I.V., 1972; Nadtochiy, E.V., Kontrimavichus, V.L., Tsimbalyuk, A.K. 1971; Tokobaev, M. M., 1976; Ryzhikov et al., 1978, 1979; Khuranov, F.B., 2000; Krivopalov, A. V., 2011; Erofeeva, V. V., 2016) who elucidated the regional peculiarities of the species diversity of parasites of micromoles.

In Uzbekistan, researches of the parasite fauna micromoles, including rodents, are reflected in the works of domestic authors (Sultanov et al., 1969, 1971, 1975; Davlatov, N., 1970; Koschanov, E. , 1972; Kabilov, T.K. , 1983; Bykova, E. A. et al., 2002), who studied the helminthic fauna of rodents, insectivores, and lagomorphs of the Fergana Valley, near Aral Sea area, and partly in Jizzakh region.

The data of the above-mentioned authors are outdated enough and the contained information is not sufficient for a vast region-Northeastern Uzbekistan.

The elucidation of the modern structure of the fauna of rodent helminthes in the investigated region and the determination of parasites common to human and farm animals, causative agents of serious diseases-anthropozoonoses is an urgent task of parasitological science and practice.

MATERIALS AND RESEARCH METHODS

The order Rodenta in Uzbekistan includes 9 modern families and 27 genera with 41 species (Shernazarov et al., 2006). A significant part of rodent species is found in natural and urbanized areas of the Northeast of Uzbekistan.

Northeastern region includes three administrative regions

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of the republic Tashkent, Syrdarya and Jizzakh. We studied rodent helminthes in all regions, taking into account the landscape distribution of animals and their activity from spring to late autumn, synanthropic-in all seasons.

The material for this work was the collection of parasitic worms from rodents in North-Eastern Uzbekistan. The researches were carried out in 2018-2020 years based on the Department of Zoology and Anatomy of Tashkent state pedagogical university and the laboratory of General Parasitology of the Institute of Zoology of the Academy of Sciences of the Republic of Uzbekistan.

Rodents of representatives of the families:

- *Sciuridae,*
- *Myocasteridae,*
- *Allastagidae,*
- *Dipodidae,*
- *Cricetidae,*
- *Gerbellidae and*
- *Muridae*

Were caught using standard live traps, crushers, traps, digging holes and pouring water. We also used the services of local hunters in Tashkent, Syrdarya and Jizzakh regions.

The captured rodents were examined by the method of complete helminthological autopsies according to (Scriabin, K.I. 1928). It was investigated about 1057 specimens of rodents (Table 1). Nematodes were fixed in Barba Gallo's liquid, flatworms-in 70% ethyl alcohol. The helminth fauna of 12 animal species was analyzed. The species identification of parasites was carried out in accordance with the keys and descriptions, given in the works of researchers (Ryzhikov, Gvozdev, Tokobaev et al., 1978, 1979; Anderson, 2000, etc.).

Table 1: Species composition of the researched rodents of North-Eastern Uzbekistan.

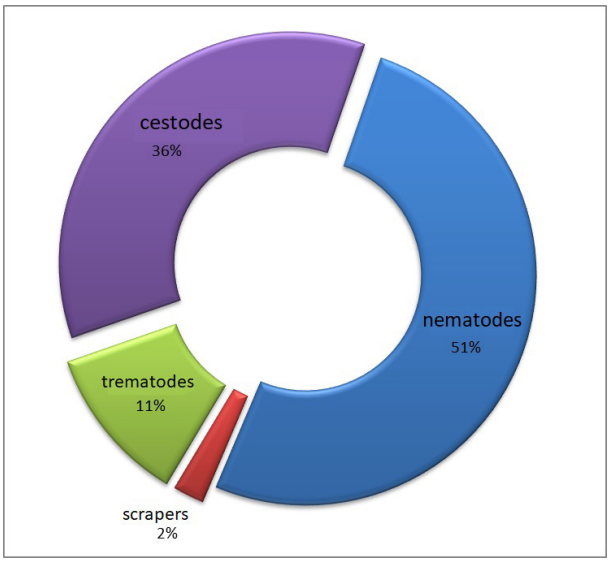
Family	Species	Investigated, specimen
Sciuridae	*Sciuris vulgaris L.,* 1758 -	11
	Spermophilus fulvus Licht., 1823 –	13
	Spermophilus relictus Kash., 1923	25
Myocastoridae	*Myocastor coypus Molina,* 1782 -	105
Allactagidae	*Allactaga major Kerr,* 1792 -	8
	Allactaga severtzovi Vinogradov	58
Cricetidae	*Ondatra zibethicus* L., 1766 -	150
Gerbillidae	*Meriones libycus Licht.,* 1823 –	45
	Meriones meridianus Pallas, 1773	42
	Rhombomys opimus Licht., 1823 –	156
Muridae	*Mus musculus* L., 1758 –	226
	Rattus norvegicus Berk., 1769 –	218
Total		1057

Further processing of the parasitological material was carried out in laboratory conditions. The study of morphology was carried out on temporary and permanent preparations using microscopes-a stereoscopic LOMA MB C-10, an inverted CK2-TR (Olympus Japan) and a VL-2200 binocular (Olympus Japan).

RESULTS AND DISCUSSION

Because of the carried out researches, we currently have information on the species composition of rodent helminthes in almost all landscape-geographical zones of the Northeast of Uzbekistan.

The total infection of the investigated 1057 rodent specimens with helminthes was noted in 357 specimens, which amounted to 39.3%. (Table 2, Figure 1). Parasitic worm infestation rates of individual rodent species vary widely. The lowest percentage of helminthes infestation in natural muskrat populations was 3.3%. High infestation was noted in the populations of gerbils (21.4%-41.0%), ground squirrels (27.0%-46.1%), Severtsov's jerboa (40.7%), house



Figures 1. Correlation of taxonomic groups of helminths in the North-East of Uzbekistan (original).

Table 2: Infection of the studied rodents - Rodentia helminths in the conditions of the Northeast of Uzbekistan.

Species of rodents	Opened, specimen	Infected		Number of parasite species			
		specimen	%	Cestoda	Trematoda	Acanthocephala	Nematoda
Sciurus vulgaris	11	2	18.1	6	2	1	5
Spermophilus fulvus	13	6	46.1	8	2	1	8
Spermophilus relictus	25	6	27.0	5	1	1	7
Allactaga major	8	1	12.4	2	-	-	3
Allactaga severtzovi	58	22	40.7	2	-	1	4
Myocastor coypus	105	19	17.1	1	2	-	1
Ondatra zibethicus	150	4	3.3	-	2	-	2
Meriones libycus	45	15	33.3	7	-	-	9
Rhombomys opimus	150	65	41.0	6	-	-	3
Meriones meridianus	42	9	21.4	9	-	-	5
Mus musculus	226	95	42.3	7	2	-	9
Rattus norvegicus	218	110	50.4	9	-	-	3
Total	1057	354	39.3				

mice (42.3%) and gray rats (50.4%).

The structure of the fauna of rodent helminthes in the Northeast of Uzbekistan consists of 46 species, belonging to 27 genera, 20 families, 9 orders and 4 classes:

Cestoda:

1. *Paramoplocephala transversaria*
2. *Catenotaenia cricetorum*
3. *Catenotaenia dendritica*
4. *Catenotaenia rhombomydis*
5. *Catenotaenia pusilla*
6. *Mathevotaenia symmetrica*
7. *Hymenolepis diminuta*
8. *8.Hymenolepis horrida*
9. *Dipylidium caninum* larvae
10. *Taenia hydatigena*
11. *Taenia macrocystis* larvae
12. *Taenia pisiformis*
13. *Taenia crassiceps* larvae
14. *Hydatigera taeniaeformis* larvae
15. *Hydatigera krepkogorski,* larvae
16. *Mesocestoides lineatus* larvae
17. *Rodentolepis straminea*

Trematoda:

18. *Echinostoma armigerum*
19. *Echinostoma mijagawai*
20. *Brachylaemus aequans*
21. *Brachylaemus recurvus*
22. *Dicrocoelium dendriticum*
23. *Acanthocephala:*
23. *Moniliformis moniliformis*

Nematodes:

24. *Armocapillaria sadovskajae*
25. *Trichocephalus cutcasheni (Petrov et Sadichov, 1957)*
26. *Trichocephalus citellorum*
27. *Trichocephalus muris*
28. *Trichocephalus rhomlomydis*
29. *Trichocephalus spalacis*
30. *Trichocephalus nutria*
31. *Heligmosomoides ryjikovi*
32. *Heligmosomoides polygyrus*
33. *Ganguleterakis spumosa*
34. *Aspiculuris schulzi*

35. *Aspiculuris tetraptera*

36. *Aspiculuris asiatica*

37. *Syphacia obvelata*

38. *Syphacia stroma*

39. *Gongylonema problematicum*

40. *Gongylonema neoplasticum*

41. *Streptophiagus kutassi*

42. *Subulura citelli*

43. *Spirocerca fedtschenkoi (Davlatov, 1970)*

44. *Physoloptera massino*

45. *Mastophorus muris*

46. *Dipetalonema viteae*

From 46 species of parasitic worms, we first noted 36 species for the fauna of rodent helminthes of the studied region of Uzbekistan. 9 species of helminthes:

• *Catenotaenia rhombomydis,*

• *Hydatigera krepkogorski,*

• *Moniliformis moniliformis,*

• *Trichocephalus rhomlomydis,*

• *Trichocephalus muris,*

• *Streptophiagus kutassi,*

• *Aspiculuris schulzi,*

• *Syphacia obvelata and*

• *Dipetalonema viteae*

were previously recorded in rodents of Jizzakh and Syrdarya regions (Davlatov, 1970; Koschanov, 1972; Muminov et al., 1986).

The species diversity of rodent helminthes in the Northeast of Uzbekistan turned out to be quite rich; cestoda and nematode are widely represented here.

The class Cestoda is represented in the studied territory by 17 species of the genera

• *Paramoplocephala*

• *Catenotaenia*

• *Mathevotaenia*

• *Hymenolepus*

• *Rodentolepis*

• *Dipylidium*

• *Taenia*

• *Hydatigera*

• *Mesocestoides*

from the order Cyclophyllida.

The families Catenotaenidae Spassky, 1950 (5 species) and Taeniidae Ludwig, 18806 (6 species) are characterized by the largest species diversity in the North-East of Uzbekistan.

The cestodes, noted by us in the mature stage live in the intestines of rodents, which are the final hosts of flatworms. Most of the cestode species are

• *Dipylidium caninum*

• *Taenia hydatigena*

• *Taenia macrocystis*

• *Taenia pisiformis*

• *Taenia crassiceps*

• *Hydatigera taeniaformis*

• *Hydatigera krepkogorski*

• *Mesocestoides lineatus*

in the larval stages inhabit in various organs of rodents, serving as reservoir hosts (Ryzhikov et al., 1978).

From the Trematoda class in the studied area, we observed 5 species of flukes in rodents:

• *Echinostoma armigerum*

• *Echinostoma mijagawai*

• *Brachylaemus aequans*

• *Brachylaemus recurvus and*

• *Dicrocoelium dendriticum*

The last two species were previously found in rodents from other regions of Uzbekistan (Davlatov, 1970; Koschanov, 1972). We found the above-mentioned trematode species in the following rodent species-*Ondatra zibethicus* and *Mus musculus* species of northeastern Uzbekistan.

In the researched region, we found the only representative of the class Acanthocephala-*Moniliformis moniliformis-in Spermophilus fulvus, Spermophilus relictus* and *Allactaga severtzovi.*

The Nematode class is represented by 23 species from the orders

• *Trichocephalida,*

• *Rhabditida,*

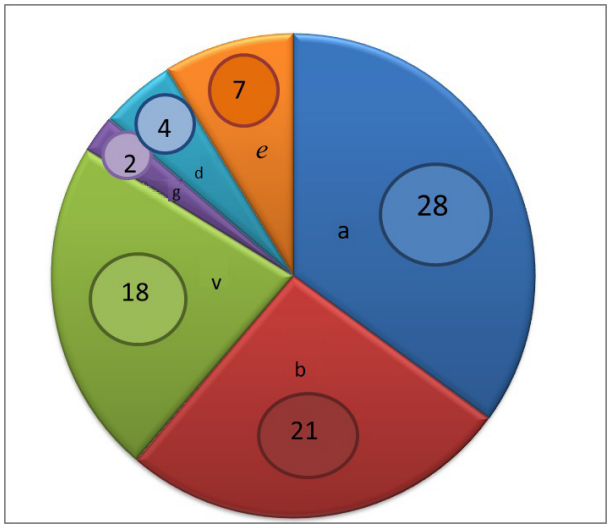
• *Oxyurida, and*

• *Spirurida.*

The order Spirurida is characterized by the largest species diversity in the Northeast of Uzbekistan-we have noted nine species of nematodes in various rodent species.

The noted nematode species turned out to be mainly parasites of the digestive system (22 species).

The species diversity of helminthes at the class level in the studied rodents is unequal (Fig. 1), which probably depends on the natural and ecological conditions of the study districts. The proportion of helminthes of certain species and groups of



Figures 2. The specific weight of the helminth fauna of individual families of rodents: a - Sciuridae, b - Muridae, c - Gerbillinae, d - Myocastoridae, d - Cricetidae, f - Allactagidae (original).

Table 3: The number of species of helminths of certain classes in rodents of different families.

Family	Total	Parasites of rodents							
		Cestoda		Trematode		Acanthocephala		Nematode	
		number	%	number	%	number	%	number	%
Sciuridae	27	11	39.2	2	7.7	1	3.5	14	50.0
Myocastoridae	2	1	-	-	-	-	-	-	-
Mactagidae	7	2	28.5	-	-	1	14.3	4	57.1
Cricetidae	4	-	-	2	-	-	-	2	-
Gerbellidae	18	7	38.8	-	-	-	-	11	61.1
Muridae	21	9	42.8	2	9.8	-	-	10	47.6

rodents is not the same (Table 3, Figure 2).

Comparison of the given in Table 3, characterizing in the most general terms of the features of the helminthes fauna of rodents of various families, allows us to conclude that its composition largely depends on the habitat and lifestyle of the vertebrate hosts. The number of helminthes species in different families of rodents differs significantly: in

- Sciuridae-27 species,
- Muridae-21species,
- Gerbillina-18species,
- Allactagidae-7species,
- Myocastoridae and Cricetidae- 6 species.

The significance of various invertebrates and vertebrates as intermediate and reservoir hosts of helminth of individual groups of rodents is not the same, respectively.

We move on to a brief description of the helminth fauna of rodents of individual families.

Sciuridae:

Among the representatives of Sciuridae, we studied three species, in which we registered 27 species of helminthes (Table 4), belonging to cestodes, trematodes, Acanthocephala and nematodes. Among the noted parasites, cestodes (11 species) and nematodes (13 species) dominate.

Table 4: Helminth fauna of the studied rodents of the family Sciuridae in the Northeast of Uzbekistan.

Species	Host		
	Sciurus vulgaris	Spermophilus fulvus	Spermophilus relictus
Cestoda			
Paramoplocephala transversaria (Krabbe, 1879)	-	+	+
Catenotaenia cricetorum (Kirschenblatt, 1949)	-	+	+
Catenotaenia dendritica (Gaeze, 1782)	+	-	-
Catenotaenia rhombomydis (Schulz et Landa, 1934)	-	+	+
Hymenolepus horrida (Linstow, 1901)	+	-	-
Taenia hydatigena (Pallas, 1766) larvae	+	+	-
Taenia crassiceps (Ledec, 1800), larvae	+	+	-
Taenia pisiformis (Bloch, 1780) larvae	+	+	-

Hydatigera taeniaformis (Batsch, 1786), larvae	+	+	-
Mesocestoides lineatus (Goeze, 1782), larvae	-	+	+
Trematoda:			
Brachylaemus recurvus (Dujardin, 1845)	-	+	+
Dicrocoelium dendriticum (Rudolphi, 1819)	-	+	-
Acanthocephala:			
Moniliformis moniliformis (Bremser, 1811)	-	+	+
Nematoda:			
Armocapillaria sadovskajae (Morosov, 1959)	+	-	+
Trichocephalus cutcasheni (Petrov et Sadichov, 1957)	+	-	-
Trichocephalus citellorum (Kirschenblatt, 1939)	-	+	+
Trichocephalus muris (Schrank, 1788)	-	-	+
Trichocephalus rhomlomydis (Schulz et Landa, 1934)	-	+	-
Trichocephalus spalacis (Petrov et Potechina, 1953)	-	+	+
Citellina alatau (Spassky, Ryjikov et Sudarikov, 1950)	-	-	+
Syphacia obvelata (Rudolphi, 1802)	+	+	+
Gongylonema problematicum (Schulz, 1924)	-	+	+
Gongylonema neoplasticum (Fibiger et Ditlovsen, 1914)	+	-	-
Abreviata leiperi (Skrjabin, 1924)	-	+	-
Physoloptera massino (Schulz, 1926)	-	-	-
S*pirocerca petrovi* (Gubanov, 1964, larvae)	+	+	-
Total	**11**	**18**	**13**

The investigated species of Sciuridae turned out as the definitive hosts of 6 cestode species, 2 trematode species, 1 species of Acanthocephala, and 13 nematode species. For five species of cestodes, Sciuridae fulfill the role as intermediate or reservoir hosts.

Mycastoridae:

In Mycastoridae, two species were identified-*Rodentolepis straminea* and *Trichocephalus nutria* (Table 5).

Table 5: Helminth fauna of rodents of the families Mycastoridae and Cricetidae of the Northeast of Uzbekistan.

Species	Host	
	Myocastor coypus	***Ondatra zibethicus***
Cestoda:		
Rodentolepis straminea (Goeze, 1782)	+	-
Trematoda:		
Echinostoma armigerum (Barker et Irvine, 1915)	-	+
Echinostoma mijagawai (Ischii, 1932)	-	+
Nematoda:		
Trichocephalus nutria (Schulz et Petrov, 1933)	+	-
Trichocephalus muris (Schrank, 1788)	-	+
Syphacia obvelata (Rudolphi, 1802)	-	+
Total	**2**	**4**

Cricetidae:

From this family of rodents, we investigated muskrat from different types of water basin. 4 species were found in the muskrat population such as

- *Echinostoma armigerum ,*
- *Echinostoma mijagawai ,*
- *Trichocephalus muris and*
- *Syphacia obvelata (Table 5).*

The first two species of trematodes develop in the aquatic environment, the intermediate hosts (molluscs) of which are easily accessible to the animals of studying. The species of nematodes noted by us are found in most representatives of rodents.

Alactagidae.

In the studied species of rodents of this family, we found seven species of parasites, belonging to cestodes, worms and nematodes. These nematodes are also found in other representatives of rodents (Table 6).

Table 6: Helminth fauna of rodents of the family Gerbillidae of North-Eastern Uzbekistan.

Species	Host	
	Large jerboa (*Allactaga major*)	**Jerboa Severtsov (*Allactaga severtzovi*)**
Cestoda:		
Catenotaenia cricetorum (Kirschenblatt, 1949)	+	+
Mesocestoides lineatus (Goeze, 1782), larvae	+	+
Acanthocephala:		

Moniliformis moniliformis (Bremser, 1811)	-	+
Nematoda:		
Streptophiagus kutassi (Schulz, 1927)	-	+
Subulura citelli (Sulimov, 1961)	+	+
Abreviata leiperi (Skrjabin, 1924)	+	+
Spirocerca fedtschenkoi (Davlatov, 1970)	+	+
Total	**5**	**7**

Gerbillidae.

In the three species of animals of this family, we have identified 18 species of helminthes (Table 7). Among them, nematodes (61.1%) and cestodes (38.8%) prevail. Gerbils (Gerbillidae) are intermediate and reservoir hosts for 4 species of cestodes such as

Table 7: Helminth fauna of rodents of the family Gerbillidae of North-Eastern Uzbekistan.

Species	Host		
	Meriones libycus	*Meriones meridianus*	*Rhombomys opimus*
Cestoda:			
Catenotaenia rhombomydis (Schulz et Landa, 1934)	+	+	+
Catenotaenia cricetorum (Kirschenblatt, 1949)	+	+	+
Catenotaenia pusilla (Gaeze, 1782)	+	+	+
Taenia macrocystis (Diesiny, 1850), larvae	+	+	+
Hydatigera taeniaformis (Batsch, 1786), larvae	+	+	+
Hydatigera krepkogorski (Schulz et Lamda, 1934), larvae	-	+	-
Mesocestoides lineatus (Goeze, 1782), larvae	+	+	-
Nematoda:			
Trichocephalus muris (Schrank, 1788)	-	+	-
Trichocephalus rhomlomydis (Schulz et Landa, 1934)	+	+	+
Trichocephalus spalacis (Petrov et Potechina, 1953)	+	-	+
Aspiculuris asiatica (Schulz, 1927)	-	-	+
Syphacia obvelata (Rudolphi, 1802)	+	-	+
Gongylonema neoplasticum (Fibiger et Ditlovsen, 1914)	+	-	-
Gongylonema problematicum (Schulz, 1924)	+	+	-
Physoloptera massino (Schulz, 1926)	-	+	-
Mastophorus muris (Gmelin, 1790)	+	+	-
Streptophiagus kutassi (Schulz, 1927)	+	+	-
Dipetalonema viteae (Krepkogorskaja, 1933) (Krepkogorskaja, 1933)	+	+	-
Total	**14**	**14**	**9**

- *Taenia macrocystis,*
- *Hydatigera taeniaformis,*
- *Hydatigera krepkogorski, and*
- *Mesocestoides lineatus.*

Muridae.

21 species of helminthes were found in Mus musculus and Rattus norvegicus. They belong to three classes-Cestoda, Trematoda, and Nematoda (Table 8). In the Muridae population of the studied district, nematodes (47.6%) and cestodes (42.8%) prevail. We noted two species of trematodes (9.5%). Acanthocephala is not found.In general, the list of helminthes of the studied groups of rodents consists of 46 species. More than thirty of them develop with the participation of intermediate and reservoir hosts (Ryzhikov et al., 1978, 1979). The remaining of 14 species of helminthes develop in a direct way.

Table 8: Helminth fauna of rodents of Muridae family in the North-East of Uzbekistan.

Species	Host	
	Mus musculus	**Rattus norvegicus**
Cestoda:		
Catenotaeniacricetorum (Kirschenblatt, 1949)	+	+
Catenotaenia pusilla (Gaeze, 1782)	+	+
Mathevotaenia symmetrica (Baylis, 1927)	-	+
Hymenolepus diminuta (Rudolphi, 1819)	+	+
Dipylidium caninum (L., 1758), larvae	-	+
Taenia hydatigena (Pallas, 1766)	+	+
Taenia pisiformis (Bloch, 1780)	+	+
Hydatigera taeniaeformis (Batsch, 1786), larvae	+	+

Mesocestoides lineatus (Goeze, 1782), larvae	+	+
Trematoda:		
Brachylaemus aequans (Looss, 1899)	+	-
Brachylaemus recurvus (Dujardin, 1845)	+	-
14		
Heligmosomoides ryjikovi (Nadtochyi et al., 1971)	+	-
Heligmosomoides polygyrus (Dujardin, 1845)	+	-
Ganguleterakis spumosa (Schneider, 1866)	-	+
Aspiculuris schulzi (Popov et Nasarova, 1930)	+	+
Aspiculuris tetraptera (Nitsch, 1821)	+	-
Syphacia obvelata (Rudolphi, 1802)	+	-
Syphacia stroma (Linstow, 1884)	+	-
Gongylonema problematicum (Schulz, 1924)	+	-
Gongylonema neoplasticum (Fibiger et Ditlovsen, 1914)	+	-
Trichocephalus muris (Schrank, 1788)	+	+
Total	**18**	**11**

Rodents are one of the most interesting orders of mammals, the ecological adaptation of which has reached a wide range-from aquatic to arboreal forms. They inhabit almost in all landscape zones of our country and are associated with components of biological diversity-communities of flora and fauna of the region of researched region. The biological connections of rodents and their parasites contributed to the formation of the modern appearance of the fauna of parasitic worms in specific territories.

Next, we will try to explain the significance of the various connections of rodents and the transmission routes of helminthes in the circulation of the invasion.

The ways of getting of parasitic worms into the final (definitive) host are different.

(Kontrimavichus, V. 1969), studying the helminth fauna of mustelids, identifies 4 ways of infesting them with helminthes: the helminth enters the host by eating other organisms, which, being intermediate or reservoir hosts, serve as objects of its food; the helminthes enters the host as a mechanical impurity to the feed or species; the parasite actively enters the host organism; the helminthes is transmitted by the intermediate host when feeding on the final host.

The noted methods are also valid for helminthes of other vertebrates, in particular rodents. In this regard, we consider to analyze the ecological relationships of rodents and their helminthes with other components of invertebrates and vertebrates in biocenoses of Northeastern Uzbekistan on the basis of original and literature data (Ryzhikov et al., 1978, 1979; Gvozdev et al., 1986; Anderson, 2000; Khuranov, 2000; Krivopalov, 2011; Erofeeva, 2016; Pazilov, Kuchboev, 2017). Table 9 shows information about the intermediate, reservoir and final hosts of rodent helminthes, registered in the biocenoses of the Northeast of Uzbekistan. In the absence of data on the biology of helminthes, parasitizing species in rodents, we tried about them on analogy with closely related forms.

Animals of many groups (invertebrates and vertebrates, Table 9) participate in the circulation of rodent helminthes.

Table 9: Participation of individual groups of animals in the circulation of rodent helminths.

Genus	Number of species	The hosts		
		Intermediate	Reservoir	Final
Cestoda				
Paramoplocephala	1	Oribatid mites	-	Rodents
Catenotaenia	4	Oribatid mites	-	Rodents
Mathevotaenia	1	Beetles	-	Rodents
Hymenolepis	2	Beetles, fleas, collembolans	-	Rodents
Dipylidium	1	Fleas	Rodents	Dogs, cats
Rodentolepis	1	Beetles, Orthoptera	-	Грызуны
Taenia	4	Rodents	-	carnivores
Hydatigera	2	Rodents	-	carnivores
Mesocestoides	1	Oribatid mites	Amphibians, reptiles, birds, mammals (rodents)	Predatory mammals
Tematoda				
Echinostoma	2	Aquatic molluscs	Amphibians, fishes	Birds
Dicrocoelium	1	Land molluscs, ants	-	Mammals
Brachylaemus	2	Land molluscs	-	Rodents
Acanthocephala				
Moniliformis	1	Beetles	-	Rodents

Nematoda				
Armocapillaria	1	Oligochaetes	-	Rodents
Gongylonema	2	Beetles	-	Rodents
Abreviata	1	Beetles	-	Rodents
Mastophorus	1	Beetles	-	Rodents
Spirocerca	1	Beetles	Amphibians, reptiles	Rodents
Streptophiagus	1	Beetles	-	Rodents
Physoloptera	1	Beetles	-	Rodents
Dipetalonema	1	Diptera insects	-	Rodents

Below we will review briefly the role of each of them.

Oligochaetes participate in the life cycle of the nematodes *Armocapillaria sadovskajae* as an intermediate host. Infection of rodents occurs only when they eat earthworms, infested by the larvae of this nematode.

Aquatic mollusks serve as intermediate hosts of two species of trematodes of the genus

• *Echinostoma: E. armigerum* and

• *E. miyagawai*

Rodents are infected by eating mollusks, infested with metacercariae, which serve as a second intermediate host. It also includes reservoir hosts, which the role is played by amphibians and reptiles.

Terrestrial molluscs of a number of species have been established as intermediate hosts for two *Brachylaemus* species:

• *B.aequanus and*

• *B. recurvus*

Rodents become infected by eating molluscs, infested with the larvae of these trematode.

For the trematode Dicrocoelium dendriticum terrestrial molluscs serve as the first and ants are the second intermediate hosts. Rodents become infected by eating ants, infested with trematode metacercations.

Acariformes: Oribatei

Considering the significance of Acariformes: Oribatei, it should be noted that, according to numerous publications, they are registered as intermediate hosts of a number of cestode species-mammalian parasites. In our material, they are intermediate hosts for 6 cestode species:

• *Paramoplocephala transversaria*

• *Catenotaenia cricetorum*

• *Catenotaenia dendritica*

• *Catenotaenia rhombomydis*

• *Catenotaenia pusilla*

Rodents become infected by swallowing ticks along with food (plants). As for another cestode-*Mesocestoides lineatus*, this includes reservoir hosts-amphibians, reptiles, birds, mammals (including rodents). In this case, rodents play the role as a reservoir host.

A number of species of beetles, orthopteran, collembolans, and fleas turned out to be intermediate hosts for representatives of cestodes-

• *Mathevotaenia symmetrica*

• *Hymenolepus diminuta*

• *Hymenolepus horrida*

• *Rodentolepis straminea and*

• *Dipylidium caninum*

For the latter species of cestodes, rodents play the role as a reservoir host.

Beetles also participate in the life cycles of a number of nematode species of the order *Spirurida* and *Moniliformis moniliformis* (Table 9).

Diptera insects were carriers of the nematode *Dipetalonema viteae*, the mature forms of which parasitize in the organism of rodents in the studied region of Uzbekistan.

Fish, amphibians, reptiles are of great importance as reservoir hosts for rodent helminthes.

Fishes participate in the life cycles of two species of trematodes, amphibians and reptiles-two species of trematodes, one species of cestodes, and one species of nematodes are as a reservoir host (Table 9).

Mammals-perissodactyla and artiodactyla, rodents are intermediate hosts of 6 species of cestodes of the genera Taenia and Hydatigera, which in mature form parasitize in the intestines of representatives of the order of carnivores.

Thus, of the total number of 46 specie-obligate and facultative parasites of rodents, 19 species are infested by eating intermediate or reservoir hosts, which is 42.2%. Eggs or larvae of helminthes enter the host's organism as a mechanical impurity to feed or water. Such species of helminthes in rodents consists of 24 or 53.0% of the total number of helminth fauna. Only the nematode *Dipetalonema vitae* is transmitted by the intermediate host when fed (blood) on the final host, which is 2.2%.

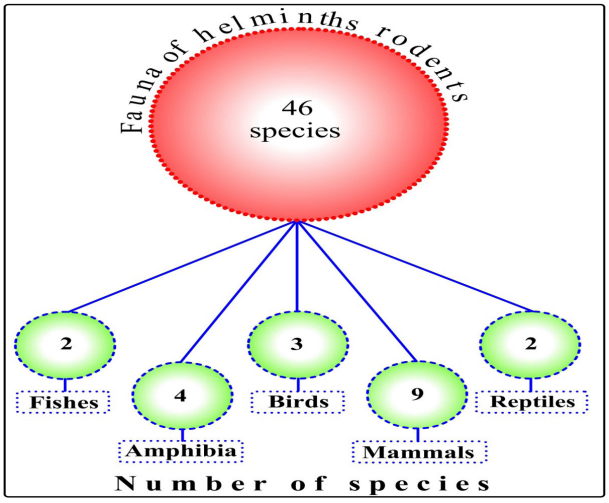
In the helminthes fauna of rodents, parasites, conjugated with topical and tropical bonds, 53.3 and 42.2%, respectively,

predominate. The ecological ties of rodents with helminthes that infect hosts with topical and trophic pathways probably determined the formation of helminth fauna of the animals studied in the north-east of Uzbekistan.

It seems to us extremely important to determine the relationship of the helminth fauna of rodents and vertebrates of other orders and classes (Figure 3).

As the data in Figure 3 fish, two species of trematodes of the genus *Echinostoma* parasitize in the metacercaria stage. Here, the fish act as the second intermediate or reservoir hosts.

Amphibians are involved in the transmission of helminthes of 4 species of the following genera-Mesocestoides (1 species), *Echinostoma* (2 species), Spirocerca (1 species). Two species from the genera (*Mesocestoides* and Spirocerca) are common to rodents and reptiles.



Figures 3. Biocenotic relationships of helminth fauna of rodents and vertebrates of other classes (original).

In birds, 3 species of helminthes of the genera *Echinostoma* (2 species) and *Mesocestoides* (1 species), which are common rodent parasites, are noted.

In mammals of other orders, nine species of rodent helminth fauna were recorded. They are represented by the following genera-

- *Taenia,*
- *Mesocestoides,*
- *Dipylidium,*
- *Dicrocoelium,*
- *Moniliformis, and*
- *Spirocerca.*

Helminthes of most of these genera were found in artiodactyls of the order Artiodactyla. Some species of the indicated genera of helminthes were also registered in mammalian orders-equids, callopods, hare-like, and insectivores (Ryzhikov et al., 1978, 1979).

Summarizing the above materials on the relationship of helminth fauna of rodents with other classes and orders of animals, it can be noted that it is quite close to the group of artiodactyls. The interactions of the helminthes of the studied rodents are also quite pronounced with representatives of other classes (fish, amphibians, reptiles, birds) and other orders of mammals that are involved in the implementation of parasite life cycles and the invasion circulation in the biocenoses of Northeast Uzbekistan.

Thus, the picture of the distribution of parasites among vertebral hosts can be explained by the host radiation of individual species and groups of helminthes, as a result of which they switch to systematically unrelated animals that live in the same biocenoses. Probably, such radiation is one of the important factors in the formation of faunistic complexes of parasitic worms.

CONCLUSION

The north-eastern region of Uzbekistan covers three large administrative regions-Tashkent, Syrdarya and Jizzakh regions, where animal husbandry is sufficiently developed. This territory is inhabited by numerous species of rodents, which are intermediate and definitive hosts of the helminth community. This is evidenced by the results of our research.

In the studied rodents, we have registered 46 species of parasitic worms. 30 species of them, we noted for the first time for the rodent fauna of Uzbekistan. The richness of parasitic worms is supported by a high species diversity of Sciuridae (27), Muridae (21), and Gerbillinae (18 species), determined by the diversity of biotopes of the studied region.

In the helminth fauna of rodents in northeastern Uzbekistan, parasites coupled with hosts by topical and trophic connections prevail, 53.3% and 42.2%, respectively. Only the nematode *Dipetalonema vitae* are transmitted by the intermediate host (mosquito) when feeding on the final host (gerbils), which is 2.2%.

Of the total rodent fauna of the studied region, 13 species of parasitic worms at a certain stage can parasitize in various

organs of domestic and wild animals and human. These include some of the following genera:

- *Hymenolepis,*
- *Dipelidium,*
- *Taenia,*
- *Hydatigera,*
- *Rodentolepis,*
- *Mesocestoides,*
- *Moniliformis,*
- *Dicrocoelium and*
- *Syphacia.*

They have medical and veterinary importance.

In general, the structural and functional peculiarities of the helminth fauna of rodents in the North-Eastern region of Uzbekistan require serious adjustments in the organization and implementation of preventive measures against anthropozoonotic helminthiasis.

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